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Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID & Zigbee with Anti-Theft

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Abstract

A supermarket is a place where customers come to purchase their daily using products and pay for that. So there is a need to calculate how many products sold and generate the bill for the customer. When we go to shopping mart for shopping, we have to work for selecting the right product. Also, after that, it is hectic to stand in line for billing all the goods. Hence, we are proposing to develop a smart shopping cart system that will keep the track of purchased products and also online transaction for billing using RFID and ZigBee. The system will also give suggestions for products to buy based on user purchase history from a centralized system. In this system, every product in Mart will have RFID tag, and every cart will be having RFID Reader and ZigBee attached to it. There will be a centralized system for the recommendation and online transaction. Moreover, also there will be RFID reader at the exit door for anti-theft.

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Keywords: Smart Cart;Smart Shopping Cart;RFID, ZigBee;Product Recommendation;Anti-Theft.

1. Introduction

Ever since the debut of wireless technology, electronic commerce has developed to such an extent to provide convenience, comfort, and efficiency in day-to-day life. The main purpose of this paper is to provide centralized and automated billing system using RFID and ZigBee communication.

Each product of shopping mall, super markets will be supplied with an RFID tag, to identify its type. Every cart contains PID (Product Identification Device). Specifically, PID contains a microcontroller, LCD, an RFID reader, EEPROM, and

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ZigBee module[1]. There will also be a centralized database from which we can give product recommendation to the customer.

Current development in chip manufacturing technology increases pratical approach for new applications. Fast growth in RFID technology is making impact on many industries[1].

The centralized database will give product recommendation and information about the product on the LCD screen present on the shopping cart, which will help the customer in buying products. LCD can display characters, numbers, and graphics[4]. LCD show the running bill[9].

The purpose of this paper is to provide an automatic billing system by using RFID and ZigBee to avoid the queue and save time in malls and super markets & to give product recommendation and information with Anti-Theft.

Table 1. Data will be store in Main Database.

RFID Tag ID	Item	Cost	Quantity
4D06D0CA	Book	600	5
4EBA8948	Biscuit	20	10
262F1E26	Bag	1000	2

2. Motivation

We have seen long queues in the supermarket that takes most of the time. While shopping consumers face many problems like worrying that amount of money brought is not sufficient, incomplete information about of the items [4]. Other than this they have to select the best product out of thousands of products. Also, want to revolutionize the entire shopping mechanism in the supermarket and attract number of customers reduce the labor cost.

Fig. 1. Problems in shopping

2.1. Why RFID?

Passive and Active these are the two categories of RFID tags. Passive tags have no battery life, and Active tags have battery life[4].Through the RFID implementation of mobile technologies and automatic recognition, technologies

become easier for smart cart[2].With the help of wireless networks, RFID makes the conventional retail process fast, transparent and efficient[2].

Table 2. Comparison between Barcode & RFID.

	RFID	Barcode
Read Rate	High throughput. Multiple tags can be read simultaneously.	Very low throughput. Tags can only read one at a time.
Line of Sight	Not required	Required
Read/Write Capability	Ability to read, write, modify, and update.	Ability to read items and nothing else.
Durability	High. Much better protected	Low. Easily damaged, cannot be read if dirty or greasy.
Security	High. Hard to replicate. Data can be encrypted	Low. Much easier to reproduce or counterfeit.
Event Triggering	Can be used to trigger certain events	Not capable.

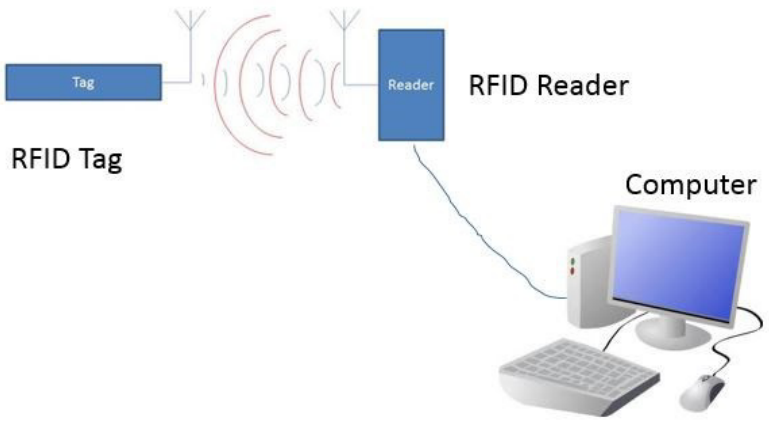


Fig. 2. Working of RFID

2.2. Why Zigbee?

Communication between shopping carts and sever take place using ZigBee. ZigBee provides low cost and low power connectivity for equipment that need battery[7]. So it increases the battery life of equipments. ZigBee provides a data rate of 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz[1].

3. Literature Survey

Literature survey shows the idea provided by the papers.

Table 3. Literature survey

Paper Title	Author	Analysis
Smart Shopping Cart with Automatic Billing System through RFID and ZigBee[1]	1) Mr.P. Chandrasekar 2)Ms.T. Sangeetha	This application creates an automated central bill system for the mall. Customers can pay their bill through credit/debit cards. Zigbee and RFID used for in it.
Novel Model for Automating Purchases using Intelligent Cart[2]	1) Ms. Vrinda 2)Niharika	This paper provides an idea of LCD use for offers, discount, and total bill.
The RFID Based Smart Shopping Cart[3]	1) Ms. Rupali Sawant 2) Kripa Krishnan 3)Shweta Bhokre 4)Priyanka Bhosale	Here a mobile device is used to make the payment of a bill via mobile applications etc.
Electronic Shopping Cart For Effective shopping based on RFID[4]	1) Kalyani Dawkhar 2)Shraddha Dhomase 3) Samruddhi Mahabaleshwarkar	In this paper, we conclude that the time required for billing in the shopping malls is cut down in self- scanning
RFID Based Smart Shopping and Billing[5]	1)Zeeshan Ali 2) Reena Sonkusare	In this paper, more utilization of LCD like removing the atom by cancel button on LCD implemented.
Intelligent Shopping Cart[6]	1)Raju Kumar 2) K. Gopalakrishna 3) K. Ramesha	It explains, how to access real time information about the diverse product inside the shopping cart.

4. Proposed System

1) Every product in the shop or a mall will have an RFID tag on it[1].
2) Each Cart will have an RFID reader and ZigBee Tran receiver implemented on it[1].
3) There will be a Centralized Server System.
4) After the payment of money, the Cart must get reset. There will be online payment procedure for billing[3].
5) If the product is removed, it must get deleted from bill too.
6) There must be an RFID reader at the exit door for anti-theft.
7) Display Product Info, Expiry Date and Better Alternative[2].

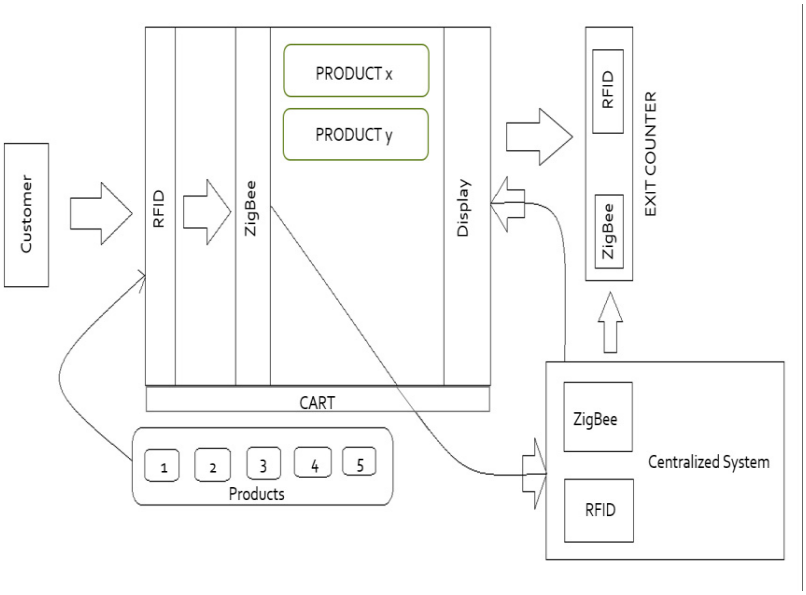


Fig. 3. Block Diagram

5. Algorithms

5.1. Bayesian Network

A Bayesian network, Bayes network, belief network, Bayes (ian) model or probabilistic directed acyclic graphical model[8]. According to this statistical model that represents a set of random variables and their conditional dependencies via a directed acyclic graph (DAG). Formally, DAGs are the Bayesian networks whose nodes represent random variables in the Bayesian sense. They may be observable quantities, unknown variables, hypotheses. Edges represent conditional dependencies; variables that are conditionally independent of each other represented using nodes that are not connected. A probability function associated takes each node as input, a particular set of values for the node's parent variables, and gives the probability distribution of the variable represented by the node.

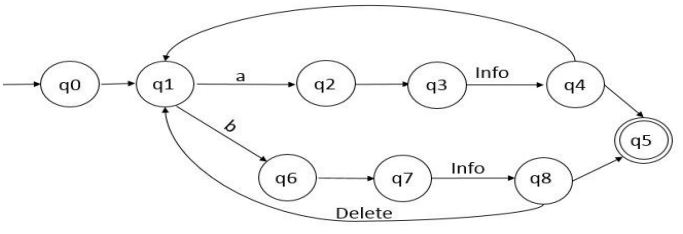
5.2. ID3

In decision tree learning, ID3 (Iterative Dichotomiser 3) is an algorithm invented by Ross Quinlan used to generate a decision tree from a dataset. An ID3 algorithm typically utilized in the machine learning and natural language processing domains. Initially, the original set S was taken as the root node in the ID3 algorithm. On each iteration of the algorithm, it iterates through every unused attribute of the set S and calculates the entropy H(S) or information gained IG (A) of the attribute.

```
Algorithm (Id,Set)
//Scan_list::List of Currently Scan Item
//Bill_list::Bill id List
//Find_Newid::Compare two list and find
//new id
//Fetch Data::Get Data from Server
//Delete::Delete item
        Set=1;
```

```
Repeat While set=1
{
        Scan();
        Scan_list();

        If (Scan_list==Bill_List)then
                Don't Do Anything
                Exit();
        Else if (Scan_list>Bill_list)then
                Find_Newid();
                Fetch_Data();
                Display();
                Add_Bill();
                Update();
        Else if (Scan_list<Bill_list)then
                Find_Newid();
                Delete();
                Update();}
```



Transition	Effect
(q0,q1)	Start
(q1,q2)	AddProduct()
(q1,q6)	RemoveProduct()
(q2,q3) | (q6,q7)	//Data sent to Server
(q3,q4) | (q7,q8)	ProductInfoDisplayed
(q4,q1) | (q8,q1)	Action 1 or Action 2
(q4,q5) | (q8,q5)	Exit()

States
Q={q0,q1,q2,q3,q4,q5,q6,q7,q8}
Input={a:Add, b:Remove}
Start Sate={q0}
F={q5}

Input	Action
a	Add Product
b	Remove Product

q1=Cart
q2=Read
q3=q7=Server
q4=q8=Display
q6=Update
q5=Exit

Fig. 4. State Transition Diagram

In state transition diagram q0, q1, …, q8 represent the multiple states. As q0 is initial state and q5 is final state. All state related information shown in the figure. Transition goes according to the inputs and reaches to the final state. The user takes a product and put into the cart then every transition goes according to the user decision at that moment.

6. Set Theory Analysis

a) Let 'S' be the | Smart Shopping Cart using RFID and ZigBee as the final set

S = {……}

b) Identify the inputs as D, E, A, Q, Z

S = {D, E, A Q, Z…}
D = {D1, D2, D3, D4 …| 'D' given database updates}

E = {E1, E2, E3, E4 …| ‘E’ given product details with price to register.}
A = {A1, A2, A3, A4 …| ‘A’ given RFID Reader and ZigBee read Product tag.}
Q= {Q1, Q2, Q3 … | ‘Q’ gives product tag to remove product from cart}
Z= {Z 1, Z 2, Z3 … | ‘Z’ given Bill to check all product at out time.}

c) Identify the outputs as O

S = {D, E, A Q, Z, N, B, L, R …|Sample space}
N = {N1, N2, N3, N4 …| ‘N’ is the Response as Generate RFID Tag to Product}
B = { B 1, B 2, B 3, B 4, …| ‘B’ is the Response as add product in Bill}
L = { L 1, L 2, L 3, L 4 …| ‘L’ Response as remove product in Bill}
R= {R1, R2 …| ‘R’ is the Response bill validate}

d) Identify the functions as ‘F’

S = {D, E, A Q, Z, M, N, B, L, R, T, F…
F = { F1(), F2(), F3(), F4(), F5() ,F6(),F7(),F8(),F9()}
F1 (D): Update Database
F2 (E): Process Requests on product details with price to register
F3 (E): Respond as Generate RFID Tag to Product
F4 (A): Process Requests on RFID Reader and ZigBee read Product tag
F5 (A): Response as add product in Bill.
F6 (Q): Process Requests on product tag to remove the product from cart.
F7 (Q): Respond to remove the product in Bill.
F8 (Z): Process Requests on Bill to check all product at out time.
F9 (Z): Response Bill validate.

Hence, the functionality can be shown as per Fig. 5.The mapping of input to output done using functions. The functions perform the operation using inputs and provide output.

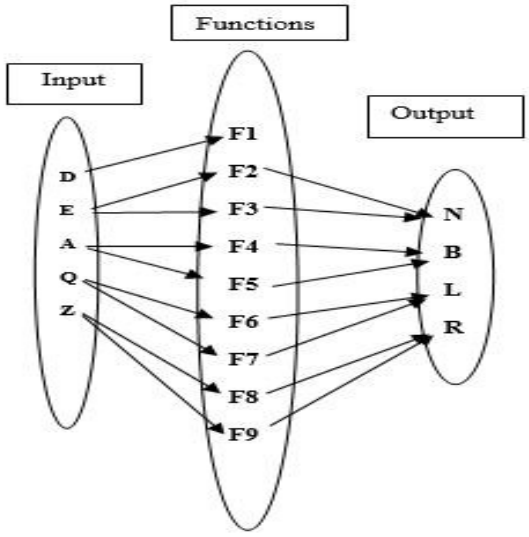


Fig. 5. Function Mapping

7. Conclusion

Each product in the shop or a mall will have an RFID tag on it. Each Cart will have an RFID reader and ZigBee Trans receiver implemented on it. There will be online payment procedure for billing. If the product is removed, it must get deleted from bill too. There must be an RFID reader at the exit door for anti-theft. Depending Upon Customer Buying Habits Display Offers/Discount on screen.Display Product Info, Expiry Date, and Better Alternative. So by making use of this, the super market shopping system will become easier. It will also provide anti- theft system for a supermarket. It will enable online transaction procedure for billing, and it will also give suggestions to the user for buying products, display offers, etc. Constraints: RFID tags and ZigBee should work properly.

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